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Fertility Control in Female White-tailed Deer

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ABSTRACT: Silastic rods containing either melengestrol acetate (MGA) or levonorgestrel (LN) were placed in anestrous white-tailed deer (*Odocoileus virginianus borealis*) does to evaluate the contraceptive efficacy of the implants over a 2 yr period. Implants of MGA were placed in five does during mid-pregnancy to evaluate the effect of this treatment on pregnancy, parturition and lactation. Pregnancies were not observed in the five animals implanted with MGA during anestrus. Three of five does implanted with LN became pregnant in the first season. Pregnancy was not interrupted in the five pregnant does implanted with MGA and it was necessary to remove the implants and treat the does with an estrogen to achieve parturition. One of five fawns was delivered alive and was raised by the doe. MGA was effective for 2 yr as a contraceptive in white-tailed deer, LN was ineffective as used, and MGA placed in pregnant does delayed or prevented normal parturition and thus should not be used in pregnant deer.

Key words: White-tailed deer, *Odocoileus virginianus borealis*, hormone implants, contraception, fertility control, captive study.

Historically, white-tailed deer (*Odocoileus virginianus borealis*) population numbers fluctuated within the limits of food supplies and habitats as a result of migration or dispersal, predation, starvation, disease, and physiological controls upon reproductive success (J. F. Kirkpatrick, pers. comm.). More recently, some wildlife populations have been managed within the limits of available food and habitat through controlled hunting, poisoning or trapping for removal. Protected deer populations can expand rapidly, damage their habitat and experience significant mortality from starvation during periods of food shortages. Deer in urban areas and protected parks may seriously damage protected or endangered plant species, compete for food resources with other wildlife, damage decorative plants in neighborhood yards and be a hazard to humans from deer–car collisions. Use of the traditional methods of hunting or controlled shooting for management are strongly contested in many urban areas and urban parks.

Fertility control as a means of controlling reproduction in wild species has been used in zoos for 15 yr (Kirkpatrick and Turner, 1985). A major study using hormone implants in captive and free-ranging feral horses (*Equus caballus*) strongly indicated effective contraception for 2 yr (Plotka et al., 1989). A controlled study on free-ranging mountain goats (*Oreamnos americanus*) indicated successful contraception for >4 yr; although difficulty was encountered with remotely delivering the contraceptive, >90% efficacy was experienced in implanted animals (R. Hoffman and B. Moorhead, pers. comm.). However, the necessary research and development on wild species have been limited in scope and have failed to demonstrate to wildlife managers that this is a useful approach to population control. This is despite the impressive technology associated with fertility control in humans and the fact that all compounds and methods available for use in humans were first tested in animals.

Effective control of reproduction in female deer can occur by interfering with neuroendocrine processes at several different steps: estrus, ovulation, conception, implantation, maintenance of pregnancy and parturition. Preventing estrus will prevent breeding at the time of ovulation by not informing the buck of the impending ovulation. Preventing ovulation, conception and implantation are additional effective methods of contraception. Inducing abortion is effective but may be considered unacceptable. Preventing parturition and retention of fetuses is unacceptable because of possible detrimental effects on the doe. Since deer are generally most accessible during the winter when they are pregnant, it is especially impor-

tant to determine the effects of contraceptives on the existing pregnancy.

Contraceptives in wild species may have secondary effects on species consuming the target animals. Significant contraceptive effects on predator and scavenger species would require that the compounds used in the target animals are orally active in the secondary species and are retained in active form in the meat or viscera of the target species in high concentrations. Also the treated animals would have to be eaten in sufficient quantity on a sustained daily basis during the reproductive season of the secondary species to exert antifertility effects.

Chemical control of fertility in a cervid was first reported by Greer et al. (1968) who administered 75 to 200 mg diethylstilbestrol (DES) to 36 captive cow elk (*Cervus elaphus nelsoni*) during midpregnancy and terminated pregnancy in 30% of the treated animals. Harder (1971) and Harder and Peterle (1974) fed 50 or 100 mg of DES/day to 101 female white-tailed deer before and during pregnancy. In pregnant does, there was significant fetal loss. Bell and Peterle (1975) found that silastic implants containing 50, 100 or 150 mg of melengestrol acetate (MGA) or 75 mg of DES significantly reduced pregnancy rates among 12 does.

Matschke (1977a) examined the effects of oral administration of DES in an encapsulated form in white-tailed deer. He concluded that this approach was not practical because of poor acceptance of the mixture by the does. Subdermal implants containing DES and the synthetic progestin DRC-6246 (17-alpha-allyl-17-beta-hydroxy-3-oxoestra-4,9,11-triene) at doses that released an average of 193 μg of DES and 93 μg of DRC-6246 per day were effective in preventing the does from becoming pregnant (Matschke, 1977b, 1980). We describe here studies on controlling reproduction in captive white-tailed deer utilizing subdermal implants containing 800 mg MGA or 200 mg levonorgestrel (LN).

Adult white-tailed does (*O. virginianus borealis*) were housed together in a 0.4 ha enclosure with at least three adult bucks in attendance at all times. Animals had free access to commercial deer pellets and were allowed water ad libitum. All animals were sexually mature at the time of placement of hormone impregnated silastic rods.

Steroid impregnated silastic rods (implants) were prepared by thoroughly mixing either microcrystalline MGA (Upjohn Corp., Kalamazoo, Michigan 49001, USA) or crystalline LN (Sigma Chemical Co., St. Louis, Missouri 63160, USA) with medical grade silicone rubber polymer (Silastic #382, Dow Corning, Inc., Hemlock, Michigan 48626, USA). Following thorough mixing, Catalyst M (stannous octoate) was added and the blend thoroughly mixed again. The mixture was then drawn into 3 ml syringes with tip-ends cut off and allowed to cure for 18 to 24 hr. Syringes were then removed and the implants soaked in saline for 48 hr followed by soaking in saline containing nitrofurazone (Schuyler Laboratories, Rushville, Illinois 62681, USA) for another 24 hr.

Implants were placed subcutaneously in the neck of does in front of the shoulder. The does were anesthetized with a mixture of ketamine (Ketaset, Bristol Laboratories, Syracuse, New York 13201, USA) and xylazine (Rompum, Haver-Lockhart, Bayvet Division, Cutter Laboratories, Inc., Shawnee, Kansas 66024, USA). The implanting site was clipped of hair and the area scrubbed with Betadine solution (The Purdue Frederick Company, Norwalk, Connecticut 06856, USA). A 20 to 25 mm incision was made through the skin and a pocket the size of the implant made by blunt dissection. The implant was placed in the pocket and the incision closed with one mattress suture using 2-0 chromic catgut suture. Each animal received 3.0×10^6 IU penicillin G benzathine and penicillin G procaine in aqueous suspension (Flo-cillin, Bristol Laboratories, Syracuse, New York 13201, USA) intramuscularly following the procedure.

The effect of hormone implants on estrus and ovulation was tested by implant-

ing each of five does with one silastic impregnated rod containing either 800 mg MGA or 200 mg LN. Three does did not receive implants and served as controls. To test the effect of MGA implants on maintenance of pregnancy and timing of parturition, five does were implanted during mid-pregnancy with one steroid impregnated silastic rod containing 800 mg MGA.

Blood was collected from all animals during the months of January, February and March to determine serum progesterone levels. The blood was allowed to clot at room temperature for 2 hr, the serum separated by centrifugation, and stored frozen until assayed for progesterone. Progesterone levels were determined using a commercial radioimmunoassay kit (Diagnostic Products Corporation, Los Angeles, California 90045, USA) modified to use charcoal stripped deer serum in the standard curve. The assay has a sensitivity of 0.1 ng and a coefficient of variation of 5.7% at sensitivity. Validation of the assay was demonstrated by recovering known amounts of authentic progesterone added to deer serum and demonstrating parallelism of deer serum dilutions with the standard curve. Ovulation was considered to have occurred when serum progesterone was 1.5 ng/ml or above. During the fawning season, the deer pens were examined every other day to determine number, sex and mother of fawns.

Data were analyzed by chi-square analysis and Student's t-test. All data are presented in the text as mean ± standard error.

The three control does ovulated, conceived and delivered three normal fawns the first year and five normal fawns the second year. One of the MGA treated does died from unrelated causes in March during the first winter. The ovaries of this doe were quiescent at necropsy. No evidence of mature follicles, ovulation or corpus luteum formation was present. None of the other four MGA treated does had elevated serum progesterone levels indicative of ovulation or produced fawns during the first breeding season following implantation of the contraceptive. A second MGA

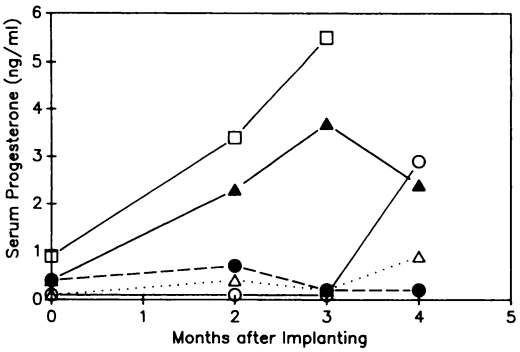

FIGURE 1. Serum progesterone (P4) concentrations before and after implanting silastic rods containing 200 mg levonorgestrel (LN). Each line and symbol type represents an individual animal. Implants were put in place during September before the breeding season.

treated doe died during March of the second year. Both of her ovaries were quiescent at necropsy. None of the three remaining MGA treated does produced fawns or had elevated serum progesterone concentrations indicative of ovulation during the second breeding season. Serum progesterone concentrations from these animals remained below 1 ng/ml for the entire 2 yr study period. Our studies confirm the effectiveness of implanted MGA as a contraceptive agent in female whitetailed deer (Bell and Peterle, 1975) and extend the documented duration of effectiveness of a single implant through 2 yr.

Matschke (1980) reported that tube-type implants containing 150 mg MGA suppressed ovulation for two breeding seasons before the steroid was depleted. Since the steroid was depleted from the implant in that short a time, Matschke (1980) felt that MGA was impractical for controlling free-ranging deer populations. We did not measure the steroid remaining in the implants from this study. However, the integrity of the implants and studies on similar implants in other species (Seal et al., 1976) indicate that sufficient steroid is present to allow the implants to last for several more years.

Two LN animals did not ovulate, based upon serum progesterone concentrations (Fig. 1). The other three LN treated ani-

mals ovulated and became pregnant although one was delayed by 2 mo. One of these does died during mid-pregnancy and was carrying normal appearing twin fawns. The other two animals subsequently delivered normal healthy single fawns the following spring. Placement and retention of the implants was confirmed by palpation in these animals.

Unexpectedly, LN was ineffective at the 200 mg dose used although the same dose is effective in humans (Sivin et al., 1982). The reason for its failure may be that this amount of hormone is only a marginally effective dose for this species.

The five does implanted with MGA during pregnancy maintained pregnancy but failed to deliver at the expected time. One animal with a full udder died after failing to deliver a single fawn. Following this observation, the remaining four animals were anesthetized and determined, by palpation, to be near full-term. The implants were removed from these four does and they were given 5 mg estradiol cypionate (Sigma Chemical Co., St. Louis, Missouri 63160, USA) intramuscularly. Four dead fawns and one live fawn were delivered spontaneously over the next several days. The live fawn successfully nursed from one of the does that received the estradiol cypionate. Serum progesterone in three of these does was below 0.5 ng/ml at the time of implant removal. The fourth doe had a serum progesterone level of 1.1 ng/ml. These studies demonstrate that pregnant does should not be treated with MGA implants unless pregnancy is terminated.

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